Unprecedented Sea Star Mass Mortality along the West Coast of North America due to Wasting Syndrome

Background

Sea stars along much of the Pacific coast of North America are experiencing a mass mortality called sea star wasting syndrome. Early signs of the syndrome can include a "deflated" appearance, unnatural twisting, or small lesions on the surface that may increase in size and number. Wasting syndrome can progress rapidly, and often leads to loss of arms, softening of tissue, and eventual death just a few days after external signs become visible. Although similar sea star wasting events have occurred previously, a mortality event of this magnitude, with such broad geographic reach has never before been documented.

Initial Emergence and Patterns for 2013

Intertidal

Wasting syndrome was first noted in ochre stars (*Pisaster ochraceus*) in June 2013 along the Washington coast during monitoring surveys conducted by researchers from Olympic National Park. ONP is part of a west coast-wide, long-term monitoring effort—the Multi-Agency Rocky Intertidal Network (MARINe), thus researchers from Alaska to California were quickly alerted to the emergence of the syndrome. Indeed, the majority of wasting syndrome-related observations are for ochre stars (the most common sea star in the intertidal). Other species affected include *Evasterias troschelii* (mottled star), *Dermasterias imbricata* (leather star), and *Leptasterias* spp (six-armed star). As of December, signs of wasting had been observed at 45 of 84 MARINe sites sampled since summer 2013, spanning the entire coast from Alaska to San Diego but varying in intensity from low levels of infection to mass mortality. Large gaps in available information hinder efforts to understand the outbreak.

Subtidal

In August, divers reported massive die-offs of the sunflower star, *Pycnopodia helianthoides,* just north of Vancouver, British Columbia and shortly thereafter, other sea star species in the region began showing signs of wasting. During October/November, a similar mass mortality event was documented in Monterey, CA, beginning with sunflower stars, then emerging in other species days to weeks later. Also in November, a significant mass mortality of sunflower and ochre stars was noted near Seattle, WA, and the syndrome appears to have spread significantly within Puget Sound, as numerous sightings of affected sea stars have since been reported to the north and south. As of mid-December, substantial numbers of sea stars with wasting syndrome were reported from southern California. Subtidal observations have thus far been largely opportunistic, and highly regional. Efforts are underway to standardize and coordinate a sampling approach, to better document the distribution of wasting syndrome in the subtidal and identify patterns of spread.

In nearly all subtidal wasting events documented during 2013, the sunflower star, *Pycnopodia helianthoides* is the first species to succumb to the disease. Other species affected (listed roughly in order of when signs of wasting first appear) include: *Orthasterias koehleri* (rainbow star), *Pisaster brevispinus* (giant pink star), *Pisaster giganteus* (giant star), *Evasterias troschelii* (mottled star), *Pisaster ochraceus* (ochre star), *Solaster* spp. (sun star), *Dermasterias imbricata* (leather star), *Mediaster aequalis* (vermilion star), *Leptasterias* spp (six-armed star), and *Patiria miniata* (bat star). It is unknown whether the disease spreads sequentially from one species to the next or if

some species simply take longer to express symptoms. Two species for which massive, geographically expansive (but patchy) declines have been well documented are the sunflower and ochre stars. Other species are less abundant, and thus impacts of wasting syndrome are less clear.

Impacts on Sea Star Populations and Broader Communities

Ecologists consider sunflower and ochre stars to be *keystone species* because they have a disproportionately large influence on the distribution and abundance of many other species. Scientists anticipate that such a large mortality event in *keystone species* could change the intertidal and subtidal seascapes. Scientists are working hard to understand the causes and consequences of the event. Previous examples of large-scale, mass mortality of individual marine species have resulted in dramatic ecosystem-wide changes.

Current Work Being Done

Field surveys are being done by MARINe groups at long-term monitoring sites along the entire west coast. Counts and size distributions of different sea star species in permanent plots can be compared to historic data, reaching back 30 years in some cases. Rapid funding from NSF, the CA Ocean Science Trust, the Packard Foundation and, OR & WA Sea Grant is supporting additional surveys to target under-represented areas of the coast (coordinated by UC Santa Cruz and Western Washington University). MARINe has also developed a tracking log that can be downloaded from the seastarwasting.org website, which can be used by researchers and the general public to record observations of wasting syndrome. Observations from field surveys and tracking logs are uploaded to the MARINe sea star wasting Tracking Map, which includes species-specific information about wasting syndrome presence/absence, and dates when sites were visited (supported by funding from Bureau of Ocean Energy Management, Packard Foundation, and Moore Foundation). MARINe members will be assisting numerous citizen science groups in WA, OR and CA to establish sites where sea star populations will be monitored for impacts of wasting syndrome. Divers and other citizens wishing to contribute observations can either join the MARINe effort or tweet in simpler observations of sick and healthy stars to www.sickstarfish.com or inaturalist.org/projects/pisaster-disaster-tracking-starfish-wasting-disease. It is very important to capture the timing of new disease clusters, since so little is known about the rate and patterns of disease spread in the ocean. Detailed data will allow testing of hypotheses about potential causes.

In addition to the MARINe effort, intertidal and subtidal surveys are being done by researchers associated with the Vancouver Aquarium in BC, Canada, the Seattle Aquarium, Friday Harbor Labs, Sea Doc Society, PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans), Santa Barbara Coastal Long Term Ecological Research Project, LiMPETS (Long-Term Monitoring Program and Experiential Training for Students), recreational divers and numerous concerned citizens. Results from all surveys will be available on seastarwasting.org.

Extensive samples have been collected to identify the microbial causative agent and the conditions that may have caused the start of the outbreak. One of the top priorities is to confirm that an infectious agent is involved and what the identity of that infectious agent is. Scientists from most locations have sent samples to Cornell University, and molecular sequencing work, funded by the National Science Foundation, is underway to identify possible viruses and bacteria that could be causative agents. Pathology samples are being evaluated by a working group of veterinary pathologists from the Wildlife

Conservation Society, Northwest ZooPath, Roger Williams University, University of California Davis, University of Connecticut and the US Geological Survey to define the disease process and help determine the underlying cause. Funding from NSF and WA Sea Grant is also supporting infectiousness experiments at Western Washington University.

Who is Involved and How to Help

Numerous universities, government agencies, aquariums, and citizen scientists have been involved in this large collaborative effort and are listed at www.seastarwasting.org. Work is underway to launch citizen science projects to help us map the spread and distribution of the disease in different sea star species and in different regions. For information about coordinated surveys being done, and the coast-wide sea star wasting Tracking Map go to:

- www.seastarwasting.org

For observations focused on the Pacific Northwest please also go to:

- vanaqua.org/act/research/sea-stars

To upload photos or tweet observations of sick or healthy sea stars go to:

- inaturalist.org/projects/pisaster-disaster-tracking-starfish-wasting-disease
- www.sickstarfish.com

For general information about wasting disease go to:

- www.seastarwasting.org